EXASSIST TECHNOLOGIES

April 6, 2021
Dr. Craig Scratchley
School of Engineering Science
Simon Fraser University
8888 University Drive
Burnaby, BC

RE: ENSC 405W/440 SimuSound Proposal

Dear Dr. Scratchley:

This letter serves as formal submission for the project proposal of SimuSound, a product that will be developed throughout ENSC 405W/440. SimuSound is a complete, head secured system that assists people with severe visual impairment or blindness by providing sufficient information to navigate their surroundings regardless of familiarity.

By using stereo vision to collect environmental information and utilizing obstacle identification artificial intelligence, SimuSound complements proven blind assistance tools such as canes and guide dogs in providing confidence and independence to its users.

The attached document provides a high-level overview of SimuSound. First, the SimuSound project will be introduced to the reader. Next, a thorough analysis of risks, benefits, target market, and existing competition will be discussed. Finally, a complete project plan along with an estimated budget is shown.

On behalf of ExAssist Technologies, I would like to thank you for your time in reviewing SimuSound's proposal. Any feedback or questions can be sent to bagnes@sfu.ca.

Sincerely,

Ben Agnes

Ben Agnes
Chief Communications Officer
ExAssist Technologies

Project Proposal

SimuSound

Partners

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Submitted To

Dr. Craig Scratchley, ENSC 405W

Dr. Andrew Rawicz, ENSC 440

School of Engineering Science

Simon Fraser University

Date of Submission

April 6, 2021

Executive Summary

Over 250 million people currently live with visual impairment or complete blindness. Long-standing aids such as guide dogs and white canes have limitations, while existing assistive technology for such individuals are very expensive and do not help those with severe or complete loss of vision. The high cost and lack of assistive options for a significant portion of the visually impaired population leaves them in a challenging position in unfamiliar environments.

ExAssist Technologies is a startup company that will disrupt the assistive technology market. We are developing a wearable device, SimuSound, that allows visually impaired individuals to easily navigate any environment by providing near instantaneous updates on precise locations of obstacles in the user's path. This is achieved by integrating 3D imaging techniques, object detection with machine learning, and localized sound synthesis into an enclosed headset.

While complex in design, with multiple sub-systems working together at high performance demands, SimuSound is easy to use. It only requires the user to secure the device to their head and power it on. Additionally, optional customizable feedback rates allow the user to tune SimuSound to their preference with the push of a button. SimuSound is intended to be used alongside tools such as white canes or guide dogs to provide information on what lies ahead, while allowing proven assistive tools to continue doing what they do best.

ExAssist Technologies plans to offer SimuSound at a forecasted price of $1000, one-third that of the cheapest competing assistive device available. Our goal is to provide a high performance and cost effective alternative that actually gives those with visual impairment full awareness of their surroundings. Additionally, the lower price makes SimuSound affordable for low to middle class income individuals, vastly increasing its market reach. Further increasing our advantage is the low cost of development as ExAssist Technologies is composed of engineering students.

By August 2021, an engineering prototype will be complete, showcasing the full abilities of SimuSound. This prototype will be used to demonstrate its capabilities to users, as well as potentially secure further development and production funding.

ExAssist Technologies' purpose is to offer a reliable and affordable device that allows those living with visual impairment to independently and confidently navigate any environment. The SimuSound project will accomplish this goal, redefining what is within reach for these individuals.

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1 Introduction and Product Overview

1.1 Introduction

There are approximately 285 million individuals living with visual impairment and 39 million with blindness worldwide [1]. In a world designed for people with sufficient vision, normally simple tasks such as crossing a street can be an extreme challenge for visually impaired individuals. Traditional assistance methods, such as the use of canes and guide dogs are useful but often have significant limitations. The universally recognized white cane can only reach a little over a meter in front and is also limited to detecting obstacles lower than waist height. Learning to use a white cane is often intimidating and requires certified training assistance for weeks or months [2]. Guide dogs require extensive training with months to a year waiting periods to receive one [3]. Additionally, not everyone is eligible to receive a guide dog due to the high maintenance and care required. It is estimated only 2% of blind and visually imparied individuals use guide dogs in the United States [4].

Previous attempts to provide technological assistance either interfere with traditional navigation methods or seek to replace them entirely [5]. Importantly, traditional navigation methods do a good job at close range, so ExAssist Technologies seeks to provide SimuSound as a solution for blind navigation that is both complementary to existing methods and provides a greatly extended range of awareness.

SimuSound combines computer vision, machine learning, and localized sounds to provide real-time and precise feedback about obstacles and the users environment. SimuSound will be inexpensive and easy to use, enabling visually impaired individuals to confidently navigate in common environments.

1.2 Product Overview

Our product is a blind assistance device that presents critical information about the environment required to navigate by using sounds. SimuSound observes the surroundings in front of it, identifies and keeps track of important objects and environmental features, and conveys the most important information to a blind user. The device will be intuitive for new users with a short learning period and not interfere with existing white cane or guide dog navigation, all while being hands free.

SimuSound achieves this by using a pair of cameras to image in front of a users head, processing those images to determine the positions and motion of objects or features relevant for navigating, and synthesizes voice descriptions to make it seem

like sounds are emitting from the position of objects. Machine learning is used to identify and segment relevant objects and then image processing makes use of stereoscopic vision to determine the three dimensional position of objects from the images. The synthesis of 3D sounds is what allows SimuSound to efficiently convey the layout of objects in the environment without using a person's sight.

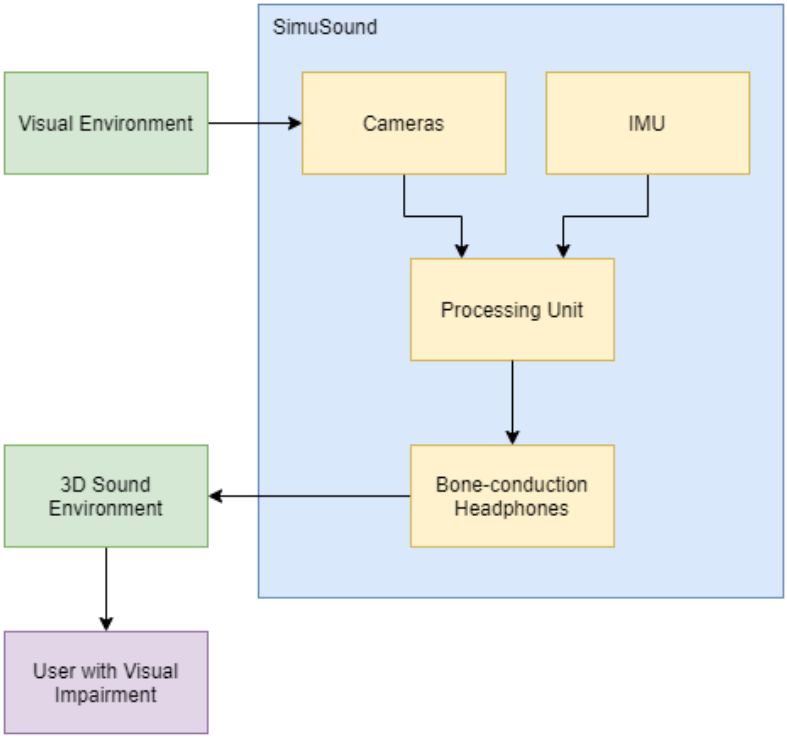

Figure 1: System overview

The proof of concept will show the plausibility of capturing basic environmental features from head-mounted cameras and navigating a foreign environment using generated 3D sound. The Simusound engineering prototype will refine the accuracy and usability of the device along with incorporating the sensor and processing components into a single physical device that can be worn. The final iteration of Simusound is expected to be housed in a lightweight and compact package with an entire workday worth of battery life.

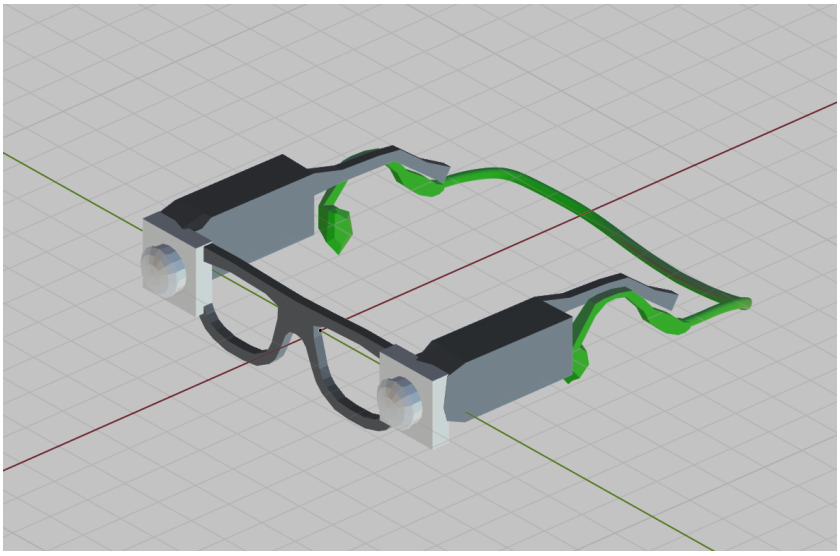

Figure 2: Engineering prototype model. The headphones are green.

Figure 3: Engineering prototype sketch. Red represents device casing and cables, blue for camera positions, green for headphones. Base image taken from [6].

2 Risks and Benefits

As SimuSound is an assistive device, it will be held to a higher standard as it has the potential to cause direct harm towards its users. Safety is our highest priority when developing this product. Firstly, the device will have direct contact with the user's skin, as well as hold a battery close to the user's head. Additionally, the system produces audio to the user via headphones, which have the potential to damage hearing if the volume is too loud or distract the user from other sounds in their environment.

Conversely, SimuSound can directly and indirectly provide significant improvements to a user's independence and lifestyle. Its components could also be used to better various technologies such as self-driving cars and survey equipment. These are further described in the Benefits section.

2.1 Risks

To mitigate the risks described above , each sub-component will be thoroughly tested as outlined in our design specification. In the event of a system failure, SimuSound will attempt to restart and stop producing feedback to avoid giving its users unreliable environmental information. The following table highlights some risks, types of risk, severity, likelihood and mitigation strategies of SimuSound and its development process.

Risk Type and Description	Severity	Likelihood	Mitigation Strategy
Strategic Risk - Selection of inferior technology to be used in SimuSound	Medium	Low	Development of PoC to test technologies and user feedback
Market Risk - System cost may be too expensive for target users to consider purchasing	Medium	Low	Perform market research and market toward larger establishments such as CNIB. Government funds may also be considered in the future
Operational Risk - Difficulty of interaction with SimuSound by target users	Medium	Medium	Perform user acceptance tests throughout development
Schedule Risk - Misjudgment of time and/or resources needed to complete each subcomponent of the device	Medium	Medium	Preemptive project planning and frequent check-ins on progress of every component of SimuSound

Cost Risk - Components for SimuSound becomes unobtainable due to financials	High	Low	Cost analysis for each component and application for suitable funds provided by SFU (e.g. Wighton fund)
Governance Risk - Development team member ignores or overlooks safety aspects of the device	High	Low	Frequent check-ins and tests of device components. Designation of alternate tasks for each member, where at least two team members have sufficient familiarity with every component
Performance Risk - Device does not provide adequate performance for users	High	Medium	Component testing throughout development and reduction of objects to be detected by device
Legal Risk - Wrongful identification of objects leading to injury of a user	High	Medium	Limit the capabilities of the device and have legal protection such as terms and conditions in place for the use of SimuSound
External Hazards Risk - Device may be tampered with, resulting in unexpected behaviour of product and unreliable information given to user	High	High	Include a physical product seal and software checks which disable the device if it was tampered with

Table 1: Risks and mitigation strategies

2.2 Benefits

SimuSound aims to provide greater independence for visually impaired person(s) in a greater variety of environments. By employing stereo vision and sound localization technologies, SimuSound extends the physical awareness of its user by notifying the user of the objects around them.

Besides general navigation, if SimuSound were to be developed and refined past the scope of ENSC 440, it has the potential to assist in more complex tasks such as navigating a grocery store and reading signs.

The technologies used in SimuSound are also very versatile. A package of similar technologies could also be adapted to fit other existing products. For instance, it can act as an addition to a motion detection or land survey system, allowing for increased performance when technologies are improved.

Furthermore, as the user interface improves, users can adjust SimuSound to fit their immediate situations. This enables its users to be able to navigate unfamiliar situations while only receiving information needed. Thus, SimuSound indirectly promotes a more active lifestyle and reduces the dependency of a caretaker.

3 Market, Competition, and Research Rationale

This section will outline the market for SimuSound and details on the current competition.

3.1 Market Analysis

Due to only having 39 million blind people worldwide, solutions for the blind population are niche [7]. Most common solutions for the blind only consist of the traditional methods such as guide dogs and walking canes.

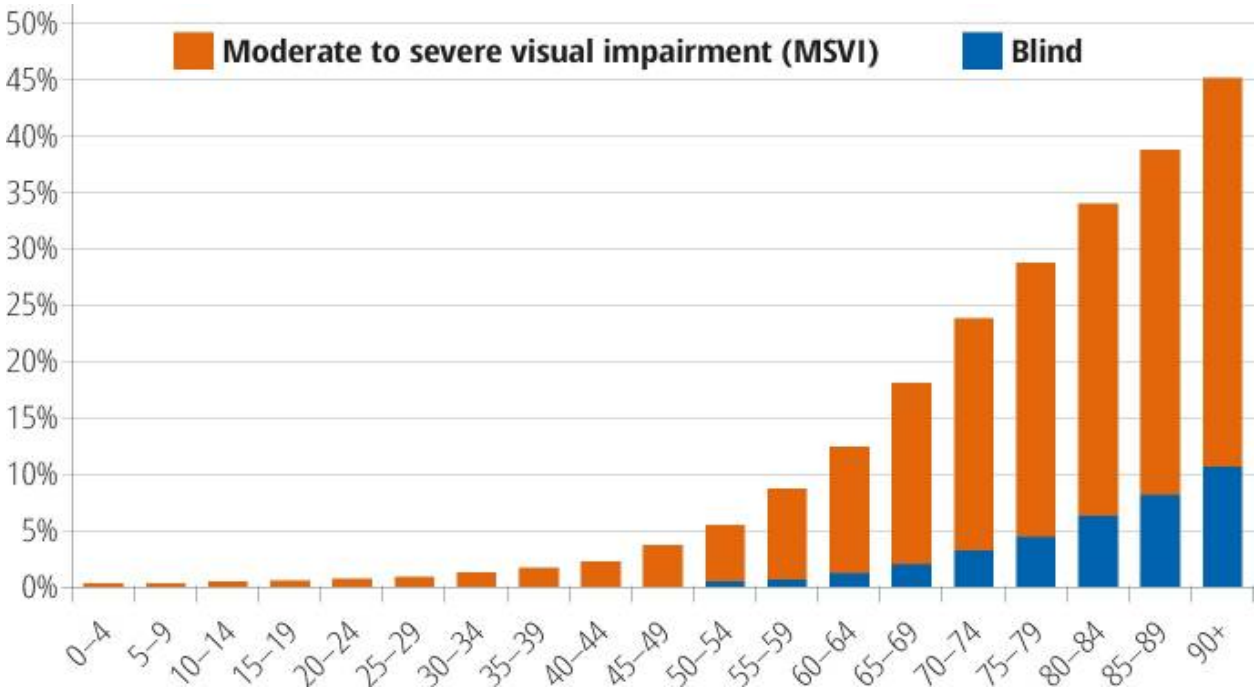

Figure 4: Moderate to severe visual impairment age breakdown. Image taken from: [7]

Figure 4 above shows the likelihood to experience eye conditions for women based on their age (result is similar for men). 89% of visually impaired people live in low and middle class income countries [7]
The poor accessibility infrastructure may hinder safe usage of canes and guide dogs.

Due to the niche market, the sale potential for SimuSound will be smaller compared to traditional products. The complete version of SimuSound is expected to be priced at CAD$1000. We offer SimuSound for the blind and visually impaired people living in North America with middle class income.

We are expecting to sell SimuSound to 0.02% of the 39 million blind people worldwide within the first year of commercialization, therefore we are expecting to earn a revenue of CAD$7,800,000. Additionally, we are aiming to sell to 0.01% of the 217 million people with moderate to severe visual impairment. The revenue generated from those sales would total CAD$21,700,000.

3.2 Competition

There are a few solutions to offering visually impaired people a way to learn about their surroundings, and they are all relatively expensive [8]. Here we show products from companies we consider to be competition.

Figure 5: OrCam MyEye Pro. Image taken from [9].

OrCam MyEyePro allows users to read text, recognize faces, and identify products. This is the most related product to SimuSound, which uses AI technology to not only read texts but to also recognize faces, identify products, colors, money notes, and read barcodes [9]. The device is attached to the right side of the glasses frame weighing at about 22.5 grams. OrCam MyEye Pro with its identification feature is considered to be our main competitor. This product was first available on Amazon on September 4, 2018 and costs CAD$5800.

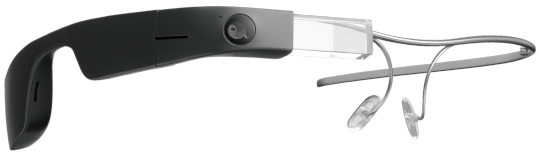

Figure 6: Envision glasses. Image taken from [10]

Envision glasses is a lightweight (46g) wearable device that also provides access to visual information about the user's surroundings. It is functionally related to the OrCam MyEye Pro in that it is trained to recognize and speak out text, objects, people, colours, and products [10]. The Envision glasses are priced at CAD$4433.

ExAssist technologies offers SimuSound at a price of CAD$1000 with the ability to recognize objects in real-time while sacrificing the functionality of reading small texts, and face recognition. Additionally, our headset will be using both ears for audio feedback to fully utilize sound localization and two cameras will be implemented to allow depth perception to determine distances of the recognized objects.

4 Project Planning

ExAssist Technologies is developing the SimuSound project throughout ENSC 405W and 440 at Simon Fraser University. The design is broken up into three phases, described below in table 2. At the end of the alpha and beta design phases, a prototype will be completed and demonstrated to showcase SimuSound to course instructors and potential investors. Figure 7 outlines the project timeline over the alpha and beta phases, with important milestones marked with stars.

Phase	Prototype	Timeline
Alpha	Proof-of-Concept Prototype	Ensc 405: Jan-Apr 2021
Beta	Engineering Prototype	Ensc 440: May-Aug 2021
Production	Final Product	Aug 2021 and onward

Table 2: SimuSound project design phases

By the end of ENSC 405W (April 2021), a proof-of-concept prototype will demonstrate SimuSounds basic functionality. Although the system is broken up into multiple components and its feedback performance will be limited, the proof-of-concept prototype will demonstrate the following:

- Providing feedback on obstacles in the user's path within 5 seconds of those objects coming into view
- Feedback utilizing localized sound, simulating the precise location of obstacles allowing the user to easily navigate towards and/or around them
- SimuSound can be used for up to 2 hours

At completion of ENSC 440 (August 2021), an Engineering Prototype that closely represents the final design for production will be showcased to course instructors and prospective investors. This stage of design will greatly improve upon the proof-of-concept prototype by encasing all parts into a headset and providing near instant feedback on obstacles in the user's path. A brief breakdown of beta phase highlights are listed below:

- Real-time feedback of obstacles in the user's path with sound localization
- SimuSound is encased entirely in a comfortable, lightweight headset. A smartphone is no longer required
- Customizable settings for rate of and types of feedback are available through simple touch buttons on the headset

Major milestones for SimuSound are listed below. To date, ExAssist Technologies has completed 5 of 8 major milestones in the project timeline. While more than half of the milestones have been completed, the next milestones in the SimuSound project require a large portion of the project timeline. Future plans for SimuSound are also presented below.

1. Company foundation, SimuSound project creation - Completed Jan 20, 2021
2. Market analysis, risk assessment - Completed February 5, 2021
3. Requirements Specifications - Completed February 21, 2021
4. Design Specifications - Completed March 26, 2021
5. Project Proposal - Completed April 6, 2021
6. Proof-of-Concept Prototype Demonstration - In Progress
7. Engineering Prototype

Future Plans for SimuSound:

- Engineering Prototype development
- Expand functionality to include detection of small and nearby objects
- Secure investment for small-scale production
- SimuSound owned by visually impaired individuals across Canada

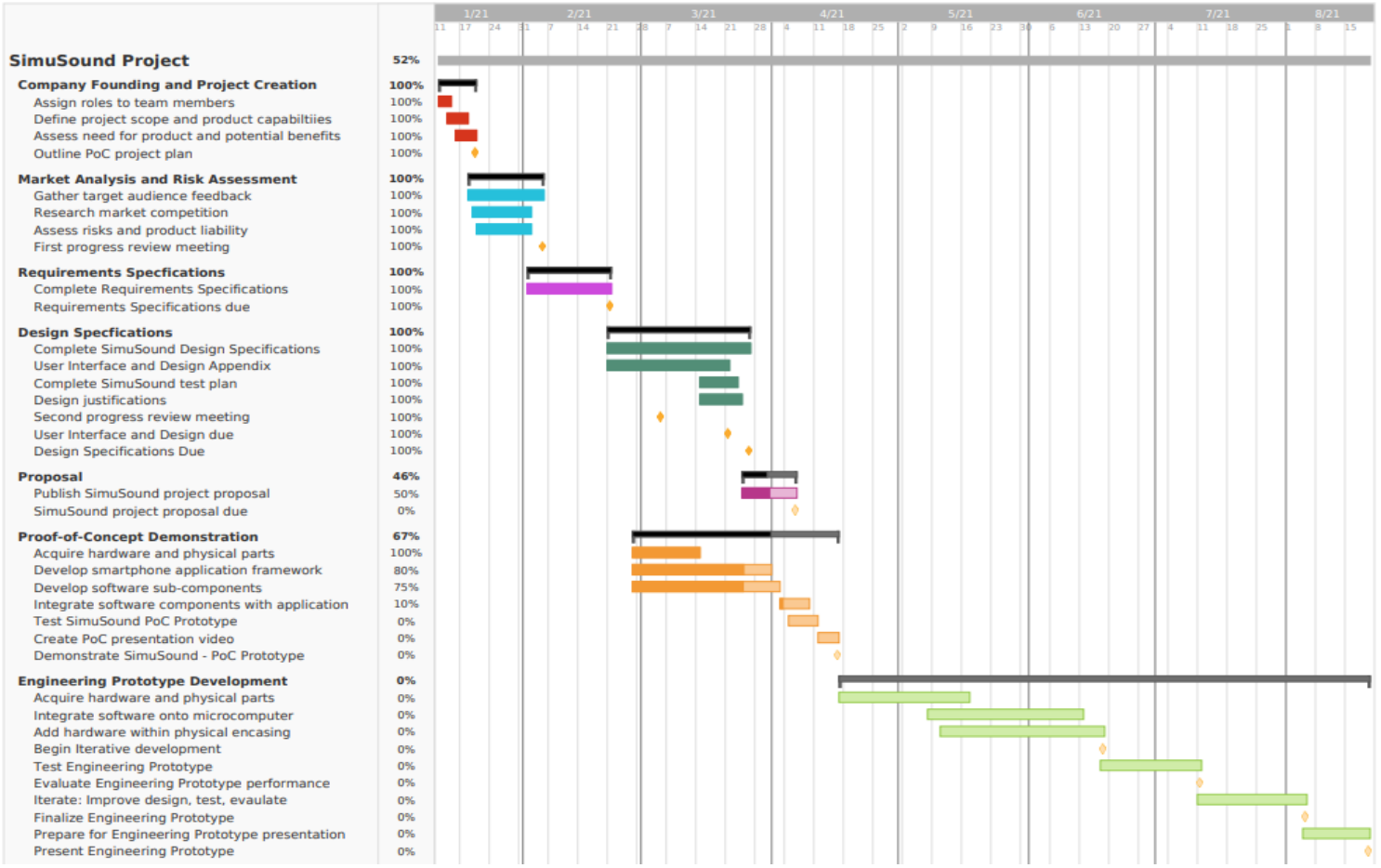

Figure 7: Project timeline for SimuSound

5 Budget and Cost Considerations

This section describes budgeting and cost considerations of the development of SimuSound, and outlines 3 potential funding sources. In the event that not all costs are reimbursed, the team has agreed to cover any additional costs out of pocket, split evenly amongst each team member. Since SimuSound is being developed as part of a University class, there are no employee cost considerations. All dollar amounts listed are in Canadian Dollars and are estimates due to price fluctuations.

5.1 Proof-of-Concept development costs

The costs for proof-of-concept development is purposefully kept low, as the goal of this phase is to determine the feasibility of the product. Estimated costs for PoC development are listed below.

Category	Item	Qty	Unit Cost	Item Cost
Hardware	USB camera module	2	30	60
	USB hub	1	12	12
	Android smartphone	1	0 (Pre-owned)	0
	Bluetooth headphones	1	0 (Pre-owned)	0
	3D printed PoC headset	1	15	15
	Miscellaneous hardware (screws, wires, etc.)	-	10	10
Research	userinterviews.com target audience survey	3	14	42
Grand total				139

Table 3: PoC development costs

5.2 Engineering prototype development costs

Engineering prototype development costs will be higher and is more likely to change compared to PoC development. Because of this uncertainty, we have added a 20% budget contingency to the total cost.

Category	Item	Qty	Unit Cost	Item Cost
Hardware	RPi CM4 board	1	80	80
	RPi CM4 development kit	1	50	50
	Intel Neural Compute Stick 2	1	100	100
	High-quality camera modules w/ lens	2	100	200
	Custom RPi to camera adapter board	1	30	30
	IMU	1	20	20
	Battery	1	10	10
	Custom power board	1	40	40
	Bone-conduction bluetooth headphones	1	70	70
	3D printed glasses w/ enclosures	1	35	35
	Miscellaneous hardware (screws, wires, etc.)	-	20	20
Research	Target audience live interview incentive	1	40	40
Contingency	Over-budget contingency	-	20% of subtotal	139
Grand total				834

Table 4: Engineering prototype development costs

5.3 Funding sources

5.3.1 Wighton Engineering Development Fund

The Wighton Engineering Development Fund [11] is a fund specifically for practical student projects. There is no formal limit on the amount that can be requested, however for Capstone projects the amount is usually less than $1000. Projects benefiting society will be given preferential consideration. To apply for funding, we will submit a written proposal describing our project in ENSC 440 Capstone B. As SimuSound is a product that we think will benefit society, we believe that we will have little issue in securing funding from the Wighton Fund.

5.3.2 Engineering Science Student Endowment Fund

The Engineering Science Student Endowment Fund (ESSEF) is a fund managed by the SFU Engineering Science Student Society (ESSS) [12]. We will be using the ESSEF to reimburse any costs that are not already reimbursed by the Wighton Fund. SimuSound falls into Category C of the ESSEF which is for class projects. The fund requires that at least one student is taking 9 or more credits in the term of application and has a CGPA of above 2.0. We satisfy these requirements, therefore we are confident that we will secure funding from the ESSEF.

5.3.3 Engineering Science Parts Budget

The Engineering Science Parts Budget is a special credit given to Capstone students for the purpose of reducing costs of using equipment such as 3D printers at SFU. It is a $50 credit provided in a "use it or lose it" manner throughout Capstone. The credit was provided informally and was associated with a faculty member, however that faculty member is no longer present, which means that there is a chance the credit will no longer be honoured by the 3D printing lab. We will attempt to utilize this credit in the PoC and engineering prototype phases to 3D print parts of our prototype.

6 Company Details

ExAssist Technologies team members are senior engineering students at Simon Fraser University. Each team member brings a unique and diverse skillset to the company, enabling ExAssist Technologies to solve complex engineering problems that will improve the quality of life of it's products users.

Michael Lin - CEO (Chief Executive Officer)

Michael is a fourth year computer engineering student, interested in software and hardware development. His expertise is in image processing, computer hardware design, and technical project leadership. He has previous co-op experience at Broadcom as a software test engineer, and at Sierra Wireless as a firmware engineer.

Michael Chambers - CTO (Chief Technology Officer)

Michael is a fourth year engineering physics student interested in physics, robotics, and software. He has experience in machine learning, computer graphics, and computer vision and completed co-ops at FLIR IIS and Microchip. Michael is working on the 3D sound synthesis system and image processing for SimuSound.

Dustin Seah - CIO (Chief Information Officer)

Dustin is in his senior year of computer engineering with interests in software systems. His past experiences include developing an app to track the effects of Parkinson's disease and co-op at Technical Safety BC. Dustin will be contributing to the audio feedback as well as testing aspects of SimuSound.

Victor Luz - CMO (Chief Marketing Officer)

Victor is a fourth year SFU computer engineering student interested in front-end software development. He has completed co-op work experience at Intel Corporation as a video compression engineer, and worked on deep learning projects. Victor will contribute in object detection designs, and market / competition research.

Ben Agnes - CCO (Chief Communications Officer)

Ben is a fourth year computer engineering student, interested in VLSI and integrated circuit design. He has completed co-ops at Kodak Canada as a systems engineer, at Sierra Wireless as an integration engineer. Ben's expertise is in SoC (System on Chip) design, hierarchical computer hardware development, system integration, and technical project management.

7 Conclusion

As a blind person, it is difficult to navigate alone in city streets and indoor spaces. We believe SimuSound is a product that will allow people with visual impairment to freely navigate with more confidence. With our product, our users will be able to locate obstacles more easily and determine an efficient path to their destination.

Our target dates are Apr 15, 2021 for proof-of-concept prototype completion, and late August in 2021 for engineering prototype completion. Based on our cost estimates, we believe that we can develop a commercially viable product that is affordable by everyday people. SimuSound distinguishes itself from its competition as its primary use is for navigating environments in real-time rather than identifying small objects. As described in the market and competition section, it will also be in the lower price range compared to its competitions, keeping it affordable to its target audiences.

This proposal outlines ExAssist Technologies' plans to develop a proof-of-concept prototype and an engineering prototype of SimuSound, demonstrating the viability of such a product. The team hopes to be able to further develop SimuSound into a commercial product that can be used by people with visual impairment across the world.

References

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